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The Director of the Trident Integrated Logistics Support Division at the Naval Sea Systems Command (NAVSEA) manages a complex and dynamic budget that supports the provision of logistics products and services to the Trident Submarine fleet. This thesis focuses on analyzing the Logistics Division budget and developing a model where the impact of a budget cut can be predicted by employing marginal costs. The thesis also explores the use of regression analysis as a means of forecasting the output of logistics end products. These forecasts are used in conjunction with historical cost data in the unit cost model. Recommendations for further research are included in Chapter V.

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Using a Unit Cost Model to Predict the Impact
of Budget Cuts on Logistics Products and Services

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ABSTRACT

The Director of the Trident Integrated Logistics Support Division at the Naval Sea Systems Command manages a complex and dynamic budget that supports the provision of logistics products and services to the Trident submarine fleet. This thesis focuses on analyzing the Logistics Division budget and developing a model where the impact of a budget cut can be predicted by employing marginal cost. The thesis also explores the use of regression analysis as a means of forecasting the output of logistics end products. These forecasts are used in conjunction with historical cost data in the unit cost model. Recommendations for further research are included in Chapter V.

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I. INTRODUCTION

This research project was initiated at the request of the Director of the Trident Integrated Logistics Division, Strategic Submarine Program, Naval Sea Systems Command (NAVSEA). The research will focus on the Logistics Division budget process. It will analyze the structure of the budget and begin developing a model which can be used to determine the impact of budget cuts on the logistics products and services provided to fleet submarine units. This chapter will provide the reader with background information on:

* The Trident Program at NAVSEA Headquarters
* Projected Funding for the Trident Program
* A Description of the Trident Logistics Division Budget Process

The Logistics Division is one of 5 divisions within the Strategic Submarine Program.[1] For the purposes of this thesis, research will focus only on the Logistics Division budget. This budget is similar to those managed by the other Trident divisions.

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[1] The Strategic Submarine Program has management responsibility for all classes of fleet ballistic missile submarines (FBM's). In this thesis, the program will be referred to as "Trident" to reflect the fact that the older classes of FBM submarines are being retired. The Trident class is the only class of submarines which is managed by the Trident Logistics Division.

A. THE TRIDENT PROGRAM AT NAVSEA HEADQUARTERS

The Trident submarine program is a sub-directorate under the cognizance of the Deputy Commander for Submarines (SEA 92) at the Naval Sea Systems Command (NAVSEA). Trident is one of several programs within SEA 92 charged with overall program management responsibility for a particular class of submarines. Other SEA 92 programs include the Deep Submergence Systems Program (PMS-395), and the Attack Submarine Acquisition Program (PMS 393).

The Trident Program Manager (PMS 396) is a Navy Captain responsible for the acquisition and life cycle management programs for Trident submarines under construction in Groton, Connecticut, as well as the 13 operational subs homeported at Bangor, Washington, and King's Bay, Georgia.

The Trident Program, which is often referred to as PMS 396, manages the integrated logistics, engineering, and technical support for Trident submarines in a "cradle to grave" context. In other words, all technical aspects of the hull, mechanical, and electronic components of each submarine are planned, monitored and managed by PMS 396 from before keel laying until decommissioning. Initial outfitting of equipment and repair parts, maintenance planning, technical training and related documentation are also the responsibility of PMS 396.

The Program Manager's staff is relatively small (around 100 persons). This requires the bulk of the workload to be performed by NAVSEA field activities, contractors and other

government activities. These activities are funded by PMS 396 to provide the technical support services mentioned above. Technical support services include the logistics products and services which are managed and funded by the Trident Logistics Division.

1. The Trident Integrated Logistics Support Division

The Trident Integrated Logistics Support Division (PMS 396L), referred to hereafter as the "Logistics Division," is charged with providing life cycle logistics and configuration data support services to fleet submarine units. The Logistics Division provides funding and technical direction to approximately 25 government activities and 7 contractors. These activities are tasked by the Logistics Division to provide the logistics products and services required in the life cycle management process.[2]

In the case of products, an activity's output can be measured in units, such as the number of Maintenance Requirements Plans (MRP's) produced or the number of repair parts issued. However, more typically the unit of output cannot be accurately measured. Logistics services are by nature intangible. Examples of intangible services are: [Ref. 1:p4]

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[2] Logistics "products" entail technical documentation such as Maintenance Requirements Procedures (MRP's) and Allowance Parts Lists (APL's). "Services" generally refer to support services such as "test and evaluation", or configuration data management.

* Assist in and/or provide technical resolution of component problems reported via Trident Command and Control Problem Reports (TCPR's).

* Perform Designated Overhaul Point (DOP) certifications and evaluations.

* Collect and review Ohio class Integrated Logistics Support product change documentation.

The intangible nature of these services makes it difficult for the Logistics Division to analyze the impact of changes in program funding levels. These difficulties will be discussed in Chapter II.

B. PROJECTED FUNDING FOR TRIDENT

In 1990, the Department of the Navy awarded the contract for SSBN 743, which will be the last of 18 Trident submarines built by General Dynamics' Electric Boat Division in Groton, Connecticut. With the completion of the Trident construction program, Trident shipbuilding and conversion funds (SCN) will be systematically reduced until they disappear in fiscal year 1998, following the delivery of the last boat. [Ref. 3]

Research and development funding (RDT&E) is also being reduced. In the case of the Logistics Division, R&D funds have been used to fund repair parts for the Land Based Evaluation Facility (LBEF) at the Naval Undersea Warfare Center in Newport, Rhode Island. As the Trident shipbuilding program draws down, the requirement for R&D funds will also taper off. OPN (Other Procurement, Navy) funding for investment items will also decline dramatically through fiscal 1999. [Ref. 3]

As the funding from the SCN and RDT&E appropriations is reduced, Trident will become increasingly reliant upon Operations and Maintenance funds (O&MN). As the primary operating appropriation for the Navy, annual O&MN appropriations are the most susceptible to Congressional budget cuts. Trident, like most Navy programs, has realized that its future viability will require much tighter control of the budget.

Controlling a large and diverse budget, such as Trident, is not a simple matter. Determining the impact of budget cuts on the levels of services and products has been a difficult, labor intensive process. It usually requires field activities to prepare impact statements based on their judgement. Horizontal cuts, which reduce funding for all programs by the same percentage, have been used to trim the budgets of funded activities. However, horizontal cuts are not always equitable. Some programs are much more deeply affected by a 10% cut than are others. Vertical cuts affect only selected programs. They are politically sensitive because difficult decisions must be made to single out individual programs for cuts. Section C will describe the Logistics Division budget process to provide an understanding of the Trident budget. This provides the background for discussing the problems that have been encountered in managing this budget.

C. THE TRIDENT LOGISTICS DIVISION BUDGET PROCESS

This section will discuss the Trident Logistics Division budget process by starting at the source of funds, the CNO program sponsor, and following the chain of accountability to the smallest subdivision of the budget. Several illustrations are provided in the appendices to clarify the process and help the reader appreciate the complexity of the Logistics Division budget process.

1. The Trident Program Sponsor

The Deputy Chief of Naval Operations for Submarine Warfare (OP-02) is the program sponsor for Trident. OP-02 allocates funding from O&MN, OPN, and RDT&E appropriations to the Trident Program Manager where they are assigned to the division with cognizance over the corresponding task. A Trident program organization chart showing the flow of funds is provided in Appendix A.

Within the Trident program, the primary interface with the OPNAV sponsor is the Business and Financial Management Division (PMS 396P). 396P coordinates program planning, budget justification, budget execution, and contract/business management for the Trident Program Director. Other 396 divisions, such as 396E and 396A manage specific technical elements of the mission. These include engineering test and evaluation and various maintenance programs. The Trident Logistics Division is funded to ensure the provision of logistics products and services to fleet units.

2. The Logistics Division Budget

In order to clarify the structure and function of the logistics budget, an illustration is presented in the appendices to supplement to the following discussion This discussion will break the budget down into its component parts. The discussion is arranged as follows:

a. Appropriation subheads

b. Logistics Division Branches

c. Field Activity/Contractor Task Statements

d. Work Breakdown Structure (WBS)

a. Appropriation Sub-heads

Budgetary authority is allocated to the Trident Logistics Division by appropriation sub-head. For example, funding for "headquarters mission support," is an O&MN appropriation with the sub-head titled "81AS". This comprises one branch of the logistics budget. Another branch, OPN, has three sub-heads, 81HH, 82P1, and 88JC. RDT&E and SCN branches have one sub-head apiece. These appropriation sub-heads are further subdivided among the Logistics division Branches, L1, L2 and L3, which assign these funds to the functional areas under their cognizance, (e.g repair, integrated logistics support and training).

b. Logistics Division Branches

Within each appropriation, the Logistics Division Branches are assigned allotments. These are then divided among the functional areas managed by each branch.

Within each sub-head, Branch Heads allocate funding to the field activities and contractors which are tasked with providing logistics products and services to the Trident fleet.[3]

Each of the funded field activities regard the Logistics Division as a sponsor, similar to the way the Trident Program Manager is sponsored by OP-02. The sponsored activities also regard the Logistics Division and its branches as "customers" to whom they provide a service. As in any customer-provider relationship, the customer expects to know what level of service the provider is producing with the funds allocated to them. To accomplish this, the sponsored activities are required to provide periodic program reviews. During the review, the sponsor is able to examine the progress of the assigned tasks and the status of funds allocated to the activity or contractor. The individual branch head is responsible for monitoring the government activities and contractors who support his functional area.

c. Field Activity/Contractor Task Statements

Task statements are prepared by the Trident Program's Technical Division (PMS 396T). They provide amplifying instructions and guidance with respect to cost, schedule and performance. The Logistics Division issues the task statements to the activities that are authorized to

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[3] Trident "fleet" includes the Trident Refit and Training facilities located at King's Bay, Georgia and Bangor, Washington.

perform the task. The activities accept the tasking and return the statement to the Logistics Division. Technical Instructions (TI's) perform a function similar to task statements, but are used in tasking contractors.[4] An example of a Strategic Submarine Task Statement is provided in Appendix C.

The task statement is essentially an agreement between the sponsor and the provider to meet the main objective. This objective will be accomplished via a series of sub-tasks. The sub-tasks describe the logistics products and services to be provided, how they will be provided and when they will be delivered.

When we speak of logistics products and services, the term "products" may be misleading. Services are generally technical support services, which are intangible. "Products", while not as intangible as services, are not products in a traditional cost accounting sense. In the case of the Logistics Division, products are mainly documentation, including maintenance plans, procurement specifications, drawings, technical manuals and Allowance Parts Lists (APL's).

The activities that provide these products generally do not track costs, such as direct labor or overhead, by product. This makes it difficult to determine the exact cost of each unit of production or to hold an activity

[4] The thesis will use only task statements for analysis due to the fact that the majority of Logistics Division tasks are performed by government activities.

to a unit cost goal. Furthermore, many task statements are comprised mainly of less than tangible services. This makes a traditional unit cost analysis inapplicable for all funded tasks. Unit cost resourcing and its applicability to the Logistics Division budget will be discussed in Chapters II, III and IV.

Each field activity or contractor may be responsible for numerous tasks funded under different appropriation sub-heads and by different Logistics Division Branches. For example, SUBMEPP,[5] a NAVSEA field activity located in Portsmouth, New Hampshire, is tasked by Logistics Division Branches L1, L2, and L3 to provide logistics products and services in four functional areas. In each of these four areas, SUBMEPP has supporting task statements describing in detail the products and services the activity is responsible for providing. SUBMEPP is only one of 25 government field activities sponsored by the Logistics Division.

The fiscal year 1993 Trident Logistics Operations and Maintenance (O&MN) budget will be supported by approximately 31 task statements and technical instructions. These are broken down into hundreds of sub-tasks. For SUBMEPP alone, the Fiscal 1993 O&MN task statements will contain 24 sub-tasks. [Ref. 2]

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[5] SUBMEPP: Submarine Maintenance, Engineering, Planning, and Procurement.

Prior to discussing the final component of the Logistics Division budget, the following list of budget components is provided as a review:

* Appropriation Sub-head
* Logistics Division Branches/Functional areas
* Sponsored Activities/Task Statements

These components sub-divide each appropriation into sub-heads which are managed by the Logistics Division Branches with cognizance over that functional area. Branch managers provide funding to field activities and contractors, who in turn provide the logistics products and services required by the submarine fleet.

The activities that are funded by the Logistics Division have agreed to provide the products and services specified in task statements. These task statements are merely specifications for the performance of a task. Tasks are not assigned funding on the task statements.

d. Work Breakdown Structure (WBS)

In order to account for each appropriation at the task and sub-task level, the Trident Program utilizes a Work Breakdown Structure (WBS). The WBS breaks functional areas into their component parts. These parts correspond to the tasks and sub-tasks found in the task statements. Each WBS task is assigned a number and corresponds to a line item in the division's budget. The budget itself is merely a spreadsheet listing each WBS number and showing the status of

funds assigned to that task. Funding is displayed for the current year, the budget year, and 6 out years. Data include the amount requested, the actual grant and the difference, which is almost always a deficit.

Using the WBS, Branch Heads are able to track the status of funds assigned to their functional area by the tasks assigned to each sponsored activity.

Although the WBS is able to track the status of funds at the sub-task level, the problem of determining the impact of changes in the level of funding still remains.

II. PROBLEMS RELATED TO CHANGES IN PROGRAM FUNDING LEVELS

This chapter discusses the problems related to managing the Logistics Division budget. The discussion is based on interviews and documents provided by NAVSEA. This discussion is not all-encompassing and relates only the problems encountered with budget formulation and determining the impact of budget cuts on logistics products and services. This discussion will describe the problems which will be analyzed in Chapters III and IV.

A. INTERVIEWS

While visiting the Trident Integrated Logistics Support Division in September 1992, the Logistics Division Branch Heads and other key personnel were interviewed concerning their experiences with budget formulation and cuts. Each interview was prefaced by stating that the purpose of this research is to analyze the structure of the Logistics Division budget and develop a model that can be used to assess the impact of budget cuts.

The individuals interviewed were senior civilian employees in grades GM-14 and 15. They had considerable experience in managing their respective budgets. Their reactions to the purpose of this study were varied. Some expressed doubt that such a complex problem could be easily solved. Some doubted that all factors which affect the levels of products and

services produced could be taken into consideration when developing a model. Other reactions were more optimistic, and some useful advice and suggestions were offered that will be taken into account when model development is explored in Chapters III and IV.

Despite these differences of opinion, all of the managers interviewed agreed that they needed an improved method for formulating the budget and predicting the impact of budget cuts. These managers also agreed that the methods that have been employed are not always efficient or equitable. Assessments of the impact of budget cuts are often based on judgement.

1. Past Practices

The Branch Heads were asked how budget cuts have been handled in the past. One Branch Head explained that he prioritized each Work Breakdown Structure (WBS) task by its relative importance to the success of his program. The least important WBS task was the first to be scrutinized for a cut. Funding for this task was reduced until it was judged to be at a level where an additional reduction would endanger the accomplishment of the task. If this task did not absorb the full amount of the cut, the next lowest priority task was cut, and so on, until the full dollar value of the cut was absorbed. [6]

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[6] Use of the term "relative importance" is not meant to imply that any of the WBS tasks are unimportant. Priorities were assigned in accordance with an activity's ability to bear a cut and continue

When asked how he determined the impact of budget cuts on logistic products and services, the same Branch Head explained that he calculated a rough estimate based on experience and a forecasted level of production for an activity. More often than not, the field activity was asked to estimate the impact of a proposed cut in the form of a reclama. Sometimes, when difficult decisions are necessary, cuts are deemed mandatory by the Program Manager and could not be appealed by a field activity.

The value of the reclamas and impact statements received from field activities is somewhat dubious. Activities have a natural tendency toward self-preservation and usually defend programs which support their reason for existence. For the Logistics Branches, it is sometimes difficult to determine whether a budget cut will adversely impact fleet readiness (as the affected activities assert), or whether it is the vitality of the field activity that is in danger.

Another method for cutting field activity budgets is to look for suspected "fat," announce the cut and wait for the activity's reaction. If the reaction is weak, or does not come at all, the cut was probably a good call. If the same activity does not become more adept at defending its program, it will probably become a candidate for additional reductions.

Cuts using this method are less common today than they were in the early to mid-1980's, when the Trident budget was

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to support the assigned task.

growing. During that period, many activities enjoyed the luxury of large budgets and were able to absorb cuts without serious damage to their programs. [7]

Nowadays, most field activities are skilled defenders of their programs. The steady decline in defense spending has placed a greater burden on Program Managers to become more efficient financial managers. The same phenomenon has honed the self defense skills of field activity comptrollers and defense contractors. This makes the Program Manager's job more difficult.

Horizontal cuts (Chapter I, part C), have been used on occasion. Generally, a horizontal cut is used when the amount of a reduction is large enough to require all logistics tasks to bear some of the burden. It would be a simple matter if a cut could be applied evenly across all programs. However, horizontal cuts require careful consideration due to their inequity.

Some activities are more significantly affected by horizontal cuts than others. Activities that have eliminated most of their "fat" are already operating on the edge, while other activities have plenty of room to become more efficient. Branch Heads recognize the inequity of horizontal cuts and the

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[7] Budget cuts are more common today than they were ten years ago. Today's cuts are more discriminating due to the fact that so many programs have already been drastically reduced Indiscriminately applied cuts would produce unwanted effects.

related difficulties in utilizing them. Thus, they generally prefer selective, or vertical cuts.

The methods discussed thus far are not scientific in nature. They rely on the experience and judgement of the Branch Heads. Due to the fast pace and dynamic nature of the Program Manager's business, most cuts are short fuzed. It is often necessary to make a decision, obtain a rough estimate of its impact, and get on with the business of providing logistics support.

It should be noted that each of the Branch Heads are professional logisticians with limited staffs. They are not budget analysts or statisticians. The daily routine of running a program such as Training is an awesome task in the fast paced environment at NAVSEA.[8] Little time is available for detailed financial or operations analysis.

2. Current Forecasting Methods

The Training Branch Head (PMS-396L3) had an organized, disciplined approach to managing his budget. The field activities funded by the Training Branch are responsible for maintaining the training curriculums at the Trident Training Facilities (TTF's) and other Navy training activities which support the Trident program. Surprisingly, most of these activities' output are products which can be measured in units. Most of these products are Training curricula and

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[8] "Training" refers to the function of the L3 branch, which manages the logistics support services for the Engineering and Operational Trainers at Kings Bay, Georgia and Bangor, Washington.

updates to existing curricula to introduce new equipment, or incorporate engineering changes to existing equipment.

For each fiscal year, the Training Branch Head forecasts the number of engineering changes. Using historical cost information, he then calculates the average expected cost per engineering change and multiplies this average cost by the forecasted number of changes, this produces a reasonable estimate.

This procedure is an informal application of Unit Cost Resourcing, similar to the program that was implemented by the Department of Defense in fiscal year 1991 [Ref. 4:p1]. Under the Unit Cost Resourcing concept, all costs incurred in a functional area are accumulated to determine a total cost. In this case, total cost is the total obligation figure for funds provided to an activity by a Logistics Division Branch during a fiscal year.[9] This total cost is then divided by the forecasted units of output for the coming fiscal year. The result is a unit, or average total cost which can be used as a planning figure for budget formulation.

By estimating the number of engineering changes, the Branch Head can determine the impact on the Training program by prioritizing each change and cutting accordingly. When a

[9] "Total obligation figure" refers to the amount of funds actually obligated by the end of a fiscal year.

specific engineering change is targeted, the reduction in related products can be estimated.[10]

Although this approach is methodical and organized, the Branch Head cautioned that determining the impact of each cut is not always as simple as calculating units of lost production.

Other Logistics Division field activities often depend on the products or services of an activity that is funded by another branch. Also, the "ripple effect" of losing a training product will be felt in the fleet. Maintenance technicians need to remain current with the latest changes to their equipment. The failure of vital equipment due to lack of training is a serious situation which the Logistics Division wishes to avoid.

Obviously, the impact of such budget decisions is difficult to determine. If the impact of budget cuts on logistics products and services could be more accurately determined, the Logistics Division would be more able to predict the effect on the end user.

B. PRODUCTS AND SERVICES NEED TO BE CONSIDERED SEPARATELY

All of the managers interviewed agreed that it would be possible to develop a model to predict a unit cost for most logistics products. Unfortunately, many of the tasks funded by

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[10] "Related Products" refer to the products produced by adding a new item of equipment, or by an engineering change. These products usually consist of documentation.

the Logistics Division are support services which are intangible and cannot be easily measured in units.

A Branch such as Training could employ one model for budget formulation and predicting the impact of cuts. However, the same model may be useless to a branch that is primarily involved with funding and overseeing services where the end products are not as easily identified.

The impact of budget cuts on services is difficult to determine. In the past, the Logistics Division has enjoyed continuity in the leadership of its Branches. The Branch Heads interviewed had all held their positions for several years. In some cases, they held several of their subordinate positions prior to becoming Branch Head. Some of the programs that are currently in place were developed by the incumbent Branch Heads.

Generally, Veteran managers can reasonably estimate how a budget cut will impact products and services using their program knowledge and their experiences with similar cuts. Experience and continuity of leadership are invaluable. However, it would be foolish to think that these individual managers will remain in their jobs forever.[11]

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[11] Three of the managers interviewed were in fact being reassigned to new positions at the time of the interview. In August 1992, The logistics divisions of the strategic and attack submarine directorates were combine to form a new logistics support division under the leadership of the incumbent Director, Trident Integrated Logistics Support Division. The consolidation resulted in the reassignment of a number of key individuals to new positions.

Another problem with experience based judgement is that each manager will use a different method to assess the impact of a cut on his program. If that manager should be reassigned, his or her successor may adopt a different method. Standardized methodology is essential for the long term vitality of the Integrated Logistics Support Division.

C. THE NEED FOR IMPROVED CONTROL METHODS

As the Trident shipbuilding program draws to a close, the Logistics Division needs to find the most efficient and equitable distribution of its resources among the field activities and contractors.

Despite the shrinking defense budget, Trident Submarines will continue to deploy on deterrence patrols and their equipment will still require a high degree of Integrated Logistics Support.

The Logistics Division will have to provide the same high quality products and services as it does now, only with less funding.

1. The Use of Quantitative Methods

In the past, the Logistics Division relied mainly upon the judgement of an experienced staff when it came to formulating a budget and assessing the impact of budget cuts on logistics products and services. Although experienced personnel are valuable in any business decision process, using improved quantitative control methods is becoming the hallmark

of successful organizations in this era of downsizing within the Department of Defense.

Quantitative methods for budget formulation have been available for a long time. In the early 1960's, then Defense Secretary Robert S. McNamara introduced operations and statistical analysis to evaluate defense programs and formulate budgets.

Analysts recognized then, as now, that the taxpayer could no longer afford budget decisions based upon intuition and judgement. In a 1966 address to the American Statistical Association, Rose Glubin of the Naval Supply Systems Command emphasized the need for quantitative analysis in budget formulation and justification [Ref. 5: p1]

> Budget justification predicated on unaided intuition instead of judgement backed by sound, objective, quantitative analysis has become suspect if not unacceptable to higher authority. As a result, management is becoming more receptive to the application of statistical methodology and techniques in the budget area.

2. Analysis Using Incomplete Information

In a budget as complex as that of the Logistics Division, it would be very difficult to incorporate all of the variables affecting an activity's output in an analytical model. The tasking for almost fifty government activities and defense contractors literally involves reams of task statements and contractual documentation that are subject to countless interrelationships. We cannot readily gather all of the information required to make highly accurate decisions. However, we can use the data that is available to make

decisions based on sound analysis rather than subjective judgement.

In his textbook Regression Techniques for Managerial Planning and Control, Professor Shu S. Liao addresses the merits of both quantitative analysis and subjective judgement in the business decision process [Ref. 6:p2]

> Almost all decisions in business as well as public organizations must be made in an atmosphere of incomplete information; a decision maker who is able to extract a maximum of useful information from available and often seemingly disorganized data should be able to make appropriate decisions and eventually prevail over the organization whose primary decision making skill involves subjective judgement. This is not to say that intuition and experience on the part of business and government executives is worthless. On the contrary, these factors are vital components in the decision making process, and must always be used if effective decisions are to be made.

It should be noted that even though using analytical techniques in business decision making is far superior to intuitive judgement, the intuition is still very important.

Mathematical models enhance a decision's accuracy and increase the likelihood that the decision will be an effective choice. However, mathematical models are not all encompassing. An experienced manager still uses judgement to assess the validity of a computed result prior to implementation.

3. Developing a Decision Model

The Logistics Division Budget is a complex and dynamic financial plan. To simplify the model development, only one of the four appropriation subdivisions of the budget will be analyzed. Fortunately, the budget is uniformly structured

across all appropriations, which will make the application of a model (or models) appropriate in each functional area.

The following chapter analyzes the O&MN portion of the budget. This budget section was chosen as a representative sample. Using the information discussed in Chapter III, Chapter IV will focus on developing simplified models for logistics products and services. Chapter V contains conslusions and recommendations for model implementation and further research.

III. ANALYSIS OF THE O&MN BUDGET

Before developing a model, a representative sample of the Logistics Division budget must be reviewed. The objective of this review is to determine whether the type of data that is required for forecasting the impact of budget cuts on logistics products and services is currently available in the task statements. This review will focus on the following questions:

* Is there an identifiable cost "driver" for each task?[12]
* Are logistics products and services clearly distinguishable from one another in task statements?
* Do task statements contain detailed cost estimates (i.e. labor, materials, and other costs)?
* Are deliverables (products and services) forecasted in units (i.e. the number of Maintenance Requirements Cards (MRC'S) to be produced for a fiscal year)?

The Logistics Branches typically do not have the time or personnel needed to analyze detailed cost accounting information. However, if a detailed analysis is to be performed, such information is essential. If the task statements were required to contain this type of information, developing and using models would be much easier.

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[12] In this case, cost "driver" refers to the source document, requirement or event which "drives" the demand for the logistics products and services specified in a task or sub-task. For example, a Preliminary Engineering Change Proposal (PECP) may be the cost "driver" for a change to a curriculum at the Trident Training Facility (TTF). This change may result in a number of end products that are related to that change.

Chapter I mentioned that the Logistics Division budget is subdivided by appropriation. This study will focus on the O&MN appropriation for several reasons.

First, ship construction funds (SCN) are being eliminated over the next 6 years as the Trident ship building program is completed. Tasks currently funded by SCN will probably not be funded by another appropriation in the future.

Second, Research and Development (RDT&E) funds are used exclusively to replenish repair parts for the Land Based Evaluation Facility (LBEF) at Newport, Rhode Island. This funding has been reduced dramatically over the past few years. Research and Development efforts at LBEF are expected to taper off as ship building draws down, making O&MN funding more appropriate for this task in future fiscal years.

Finally, even though O&MN and OPN appropriations are very close in dollar value for fiscal year 1992, OPN will decrease at a much faster rate until 1999 when O&MN will dominate the Trident Logistics budget by a ratio of almost 2 to 1. [Ref.3]

With these facts in mind, the O&MN task statements were chosen as a representative sample. These task statements contain tasking for logistics products and services funded by all three Logistics Division branches. The analysis of these task statements is expected to determine whether data that is required for model development is currently available.

A. DEFINING UNITS OF OUTPUT

An essential element in developing any quantitative model is a well defined output that is measurable in units. In this case, a forecast of the expected number of units to be produced is necessary to calculate a cost per unit of output.

Under the Unit Cost Resourcing concept, the Department of Defense has defined a number of standard units of output for support services. These units of output will be used to calculate a cost per unit. The total cost of last year's output is divided by the expected number of units of output for the following fiscal year. Some examples of measures of output are shown in Table 1. [Ref. 7:p14]

TABLE 1 OUTPUT MEASURES BY FUNCTION

Commissaries	Cost per sales dollar
Depot Maintenance	Operating results based on cost goals
Distribution Depots	Cost per item shipped/received
Finance/Accounting	Cost per civilian paid Cost per invoice paid
Recruiting	Cost per recruit contract
Training	Cost per graduate
Research and Development	Billable Hours

It is not always easy to identify an activity's output. For example, the output for a research and development lab, billable hours, could also be an input (labor). [Ref. 7:p13]

In the case of logistics products and services, the units of output are especially difficult to define. O&MN task statements contain a myriad of products and services. Some products are readily identifiable, such as the number of

Maintenance Index Pages (MIP'S) or Maintenance Requirements Cards (MRC's) produced. Other products and services are not as easily identified. For example, a service such as "Curriculum Surveillance" involves a number of sub-tasks. The output for such a service is normally documentation, reports, and curriculum changes. These are generated as required based upon a level of input.

Table 2 illustrates some of the end products which are found in the O&MN task statements.[13] These end products are classified as "tangible," or "less tangible," depending on their measurability in units.

TABLE 1 LOGISTICS END PRODUCTS

TANGIBLE	LESS TANGIBLE
Maintenance Requirements Cards	Curriculum Maintenance
Maintenance Index Pages	Curriculum Surveillance
Curricula Updates	Travel (also an input)
Refurbished Pre-faulted Modules	Review Reports and Recommendations
Refurbished OJ-197 console	Task Management
Training curriculum A-183-0018	Test and Evaluation

Logistics services are generally intangible and are normally related to oversight or monitoring of a particular function. With few exceptions, these services are labor intensive. It is possible to measure labor in units which in

[13] The term "end products" refers to the output idnetified for each task/sub-task in a task statement.

turn can be correlated with levels of output. Examples of labor or work units are man-hours, days, weeks, and years.

A common work unit within the Department of Defense is work-years, and will be the work unit referred to in this thesis.[14] Many of the government activities funded by the Logistics Division account for their labor by assigning work years of effort to each task. In this case, 1 work year could be correlated with a number of units of output. This raises two questions. How can the Logistics Division Branch Head determine the number of units produced per work year of input? How will services be reduced if funding is reduced by the equivalent of (X) work years?

B. HISTORICAL DATA IS ESSENTIAL

In addition to well defined units of output, it is essential to maintain historical cost data broken down by task. At the present time, not all WBS tasks and sub-tasks described in the O&MN budget closely correspond with the descriptions of tasks and sub-tasks on the task statements. Some WBS budget lines correspond directly to task statements, but are aggregate totals and not broken down by sub-task. At the Program Manager's level, data reported by task is probably sufficient detail. However, detailed sub-task cost and unit output data should be maintained and made available to Branch Heads and other decision makers for analysis.

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[14] 1 Work year = 2,000 man hours or 50 40 hour work weeks per year for 1 employee.

If historical cost data is accumulated, it must be broken down in sufficient detail for each task statement in the budget. When formulating the budget, a Branch Head should be able to quickly determine historical cost and units produced for a particular type of product by consulting an automated database.

Another advantage of maintaining a historical database is its value as an audit trail. With the information currently available, it would be difficult for anyone to determine the cost and production history of an output other than those who have been directly involved with a task.

Finally, historical data is required to the apply forecasting tools such as regression analysis.[15] Such statistical tools are very useful to predict the number of units to be produced based upon various predictor variables.

C. ELEMENTS OF THE COST EQUATION

Now that the requirement for historical data has been discussed, it is appropriate to differentiate between the elements of the cost equation. For each task or sub-task, total cost (TC) is the total funds obligated by an activity in executing the task/sub-task. Total cost is comprised of two elements, fixed cost (FC) and variable costs (VC). Stated mathematically, the cost equation is displayed in Figure 1.

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[15] Regression is a statistical technique in which an outcome can be forecasted by manipulating one or more predictor variables in a linear equation.

TOTAL COST = FIXED COSTS + VARIABLE COSTS
TC = FC + VC

Figure 1

Until now, the discussion of historical costs has referred only to total cost. While total cost is important for budget formulation, it is not useful for predicting the impact of a budget cut on logistics products and services.

1. Variable vs. Fixed costs

Variable costs are those costs that fluctuate with the level of activity. Examples of variable costs are direct materials, direct labor and variable overhead. The other element of total cost, fixed cost, does not fluctuate (in the short run) with the level of activity. Examples of fixed costs are capital equipment, Base Operations Support (BOS) costs and management salaries.

When analyzing an activity's productivity, only the variable cost element should be considered. In theory, if an activity produces zero units of an end product, total costs will equal fixed costs (TC = FC). As the activity begins to produce units of the end product, it incurs costs that are directly related to the product. These variable costs are the costs that should be considered when developing a model to predict the impact of budget cuts. Total variable costs, when divided by total output, will result in an average variable cost (AVC). The DoD unit cost model considers average total costs. The unit cost model described in Chapter IV is a

modified version of the DoD model that employs marginal cost to demonstrate the impact of a budget cut on logistics products and services.

2. Marginal Cost

Marginal cost is the additional cost incurred as output is increased by one unit. [Ref.8 :p37] The theory of marginal cost is one of the central tenets of micro-economic analysis. As discussed in the last section, total cost will equal fixed costs when the output is zero. Only variable costs will change in the short run. Therefore, the change in total cost must equal the change in variable costs. Figure 2 illustrates this example. [Ref.8 :p37]

(1) $TC = FC$ when $Q = 0$

(2) therefore $\Delta TC = \Delta VC$ as Q increases.

(3) $MC = \dfrac{\partial TC}{\partial Q} = \dfrac{\partial VC}{\partial Q}$ (because only variable costs change in the short run).

Where:
Q = Quantity Produced
TC= Total Cost
FC= Fixed Costs
VC= Variable Costs
MC= Marginal Costs

Figure 2

Marginal costs can be useful when assessing the number of additional units of an end product that can be produced given an increase in funding, or how many units of production can be lost due to a budget cut.

Marginal costs can also be used to allocate funds across several tasks or activites. Through the use of calculus, managers can optimize the utility (value) of several tasks when a limited amount of funding is available to support them (constrained optimization).

In the remainder of this thesis, the term "unit" costs will refer to average total cost when discussing budget formulation, and to marginal cost when discussing budget cuts. Chapter IV will discuss a modified unit cost model that employs marginal costs.

D. FORECASTING UNITS OF OUTPUT

Another essential element of budget modeling is a forecasted output for each end product. If a unit forecast for the "driver" is developed, a similar forecast for the units of end products could be derived. Again, historical data is required before accurate forecasts can be generated.

In order to forecast the output associated with a particular task, a manager must know which event or document "drives" the requirement for that output. For example, the PECP's mentioned in Footnote 12 drive the requirement for curriculum changes. [Ref. 9:p1-5] If historical data were available, the expected number of PECP's (for a period of time) could be forecasted. Once the expected number of PECP's is known, the related end products could also be forecasted.

The theory is simple. For each identifiable output, there must be a corresponding requirement that drives the demand for that output or end product. Another example of requirement and output is the refurbishment of computer hardware by an industrial activity. The requirement could be the expected number of equipment failures or the replacement schedule for a particular piece of equipment. These requirements can be used in forecasting an expected number of units that will require refurbishment. An experienced logistician could determine the end products resulting from refurbishing one unit, and determine the total end products reulting from refurbishing all units forecast for a period of time. Unit forecasts are also helpful in predicting the impact on products and services as a result of budget cuts.

Although this process seems simple, identifying the "drivers" for all end products is not easy. As discussed in Chapter I, there are literally hundreds of tasks in the Logistics Division budget which result in a wide variety of end products or services.

Determining the relationship between these "drivers" and their corresponding end products would require considerable input from experienced Logistics Division personnel. These "drivers" and products will need to be identified if a decision is made to develop an analytical computer model on a division wide scale. A task of this magnitude will require a considerable level of effort over a long period of time.

E. ANALYSIS OF THE O&MN TASK STATEMENTS

The Trident O&MN budget was examined in detail. For simplicity, only the task statements from government activities were reviewed. Although there are a few contracts that account for a significant percentage of the budget, the bulk of the WBS tasks are assigned to government activities. (A diagram depicting the Logistics Division budget is presented in Appendix B).

Under the appropriation sub-head 81AS, O&MN funds are divided among branches L1, L2 and L3 to fund specific program functions such as Integrated Logistics Support (ILS), TRIPER,[16] Reliability, Maintainability, and Availability (RMA), and the Engineering Operational Trainer (EOT).

Thirty-one task statements were reviewed. The statements varied in format and content from branch to branch. Their technical requirements and complex language resembled government contracts. An auditor with no previous Trident Program experience would require considerable assistance in translating the acronyms and learning the relationships between the tasks and the resulting end products. Fortunately, the questions presented on the first page of this Chapter were answered relatively easily. The reader is reminded that

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[16] TRIPER stands for Trident Planned Equipment Replacement Program. During a ship's refit period, equipment that is scheduled for periodic maintenance is removed from the sub and quickly replaced with a refurbished unit from a pool of assets maintained for this purpose.

inferences regarding possible "drivers" or end products are suggestions. The units used as examples are not the only correct choices. If a division wide working model is developed, the choice of inputs (drivers) and outputs (end products) will require careful consideration by Logistics Division managers who have experience with the relationships between the WBS tasks and their end products.

1. Identification of the "Drivers"

Of thirty-one task statements reviewed, potential "drivers" were identified in virtually all cases. As mentioned earlier, "drivers" are the source, event or document that "drives" the requirement for a logistics product or service. A "driver" should be measurable in units. Some of the "drivers" on the less complex task statements were easy to identify. Others were not as apparent, and will require the judgement of a person who is familiar with the task. Some of the "drivers" that have been identified are:

* Preliminary Engineering Change Proposals (PECP's)
* Engineering Changes (EC's)
* Regular Meetings (for travel purposes)
* Baseline Revisions to Equipment Configurations
* Trident Command and Control System Problem Reports (TCPR's)
* Pre-faulted Modules (PFM's) requiring refurbishment.
* Issues or Receipts (repair parts)

One "driver that appeared to be a common root for many O&MN tasks, particularly in the L3 (Training) branch, is the

Preliminary Engineering Change Proposal (PECP). PECP's initiate the Trident engineering change and modification process and appear to be one of the primary sources for curriculum changes and related products. PECP's can be measured in units and historical data is maintained by the Logistics Division. The probability that PECP's can be forecast accurately by regression or other statistical technique is excellent.

Another possible "driver" appearing in a number of task statements is units of equipment. These task statements cover the refurbishment of repairable equipment by Navy industrial activities such as the Naval Undersea Warfare Center (NUWC). Forecasting an expected number of units that will require refurbishment is an established process at other Navy commands. For instance, the Naval Sea Logistics Center (NAVSEALOGCEN) at Mechanicsburg, Pennsylvania, collects logistics and cost data for fleet equipment.[Ref.10]

Through the analysis of historical cost data and a forecast of units to be refurbished, a reasonably accurate unit cost could be calculated. This unit cost would be of great value in budget formulation and predicting the impact of budget cuts.

Regular meetings can "drive" the requirement for travel.[17] Travel is an expense which is readily measurable in

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[17] Although travel is regarded as an input under Unit Costing, one of the task statements reviewed listed it as an end-product. The requirement for that travel needs to be forecasted in units.

units (trips) and can be forecasted by using historical data and a schedule of future meeting requirements.

Tactical Changes are another "driver" for training curriculum updates. Tactical Changes result from changes in doctrine or procedure (as opposed to PECP's which result from engineering changes to hardware or software). If historical data is available, Tactical Changes could also be forecasted.

Finally it should be noted that some task statements are of a one-time nature or fund one specific task such as the production of a telecommunications map for OCRIM. [18] This type of task is easier to manage financially due to the brevity and simplicity of the task statement.

2. Distinguishability of End Products and Services

The final section of each task statement contains a summary of the sub-tasks and their corresponding end products. These are listed on the lower section of each page. The term "end product" is a catch-all and covers a wide variety of outputs. Some of the end products that were identified are:

* Engineering support
* Software, hardware, and documentation upgrades
* Maintenance of the Change Status Summary Report (CSSR)
* Training Material Control Forms (TCMF's)

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[18] OCRIM is the acronym for Ohio Class Resource Information Management, a nationwide logistics and maintenance database linked by a telecommunications network. It is unique to the Trident program.

* Curricula Updates

* Financial status report

(Other end products are listed in Table 2)

A common end product for the L3 (Training) branch is the Curriculum Update. Curriculum Updates can result from hardware modifications initiated by PECP's and Tactical Changes. If the expected number of PECP's and Tactical Changes were forecast, an expected number of Curriculum Updates could also be derived. If PECP's were prioritized (for budget cutting purposes), the impact on the curriculum updates could be predicted if funding for lower priority PECP's is reduced or deferred.

There are a number of management reports which are generated in addition to actual end products. While these reports are deliverables and are listed as end products, they should be listed separately from "hard" end products such as Maintenance Requirements Cards (MRC's) or Pre-faulted Modules (PFM's).

On the whole, end products and services are distinguishable from one another. It seems appropriate to list only those hard copy products that directly impact fleet readiness as "end products" Other reports, such as financial status reports, should be listed as "Other Reports and Documentation."

3. Availability of Detailed Cost Estimates

With only a few exceptions, the task statements did not contain cost estimates other than the aggregate total presented on the first page. It is not recommended that the Logistics Division begin micro-managing the field activities. However, detailed cost estimates should be provided by the field activities prior to allocating funds by the Logistics Division. At a minimum, the following information should appear in the task statements:

* The total projected cost for the budget year and out years.
* A breakdown of total cost into its fixed and variable elements for each sub-task.
* A breakdown of government and contractor workyears assigned to each sub-task.
* A summary of government and contractor personnel assigned to each sub-task.
* A forecast of unit cost for each identified end product or service.
* A forecast of the expected output in units (for the budget year).

At first glance, this list appears to contain too much detail considering the number of tasks managed by the Logistics Division and the limited amount of time available for analyzing such data. However, this level of detail is necessary to compute unit costs and compare one activity with another.

Comparability is very important. For example, a manager compares two activities that produce comparable end

products, such as Curriculum Updates. If cost and production data were available, the manager could compare the unit cost per Curriculum Update for each activity.[19] Table 3 illustrates this example.

TABLE 3	Activity A	Activity B
Curriculum Updates	70	95
Direct Materials	25,000	34,000
Direct Labor	105,000	115,000
Travel	15,000	10,000
Other Variable Costs	10,000	7,500
Total Variable Costs	155,000	166,500
Avg. Variable Cost per Unit	2,214	1,752

The difference in variable unit cost ($462.00) is sufficient cause for further analysis. There may be a good reason for the difference, such as higher labor costs, which are an uncontrollable expense for some activities.[20] However, this difference may result from a disparity in the production

[19] Fixed costs, such as Base Operations Support (BOS) are not considered in this example. The costs listed in Table 3 are variable costs and fluctuate with the level of activity. In most micro-economic analyses, varible costs or average variable costs (AVC) are used to measure an activity's productivity and efficiency.

[20] "Uncontrollable" refers to the fact that some government activities are staffed with higher civilian pay grades than others. This is sometimes related to geographic location. Some tasks may require a person with a higher pay grade due to the level of knowledge and experience required.

efficiency between two activities. In this case, the manager may exert pressure on the activity to improve their efficiency and lower their unit cost or face a reduction in funding.[21]

Another argument against activities providing detailed information is that it will mean more work for the activity comptroller's staff. Granted, the initial generation of this data will require a considerable expenditure of personnel hours. However, once a baseline has been established, periodic updates will be less time consuming and expensive.

A final consideration for requiring field activities to provide detailed cost estimates is the natural tendency toward self-preservation mentioned in Chapter I. Activities may be reluctant, and understandably so, to provide what they view as proprietary information. Self-preservation may also introduce the incentive to distort data to further one's agenda (gameing). Also, after of years of doing business under the current practices, the activities may balk at having to justify their requirements in minute detail. Fortunately, the Program Manager holds the upper hand in this case. If detailed cost information will enable the Trident Program to more efficiently allocate its shrinking resources, the inconveniences experienced by the field activities are for a common good and will not be in vain.

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[21] Although unit costs are a valuable tool when making workload or reallocation decisions, they may only be an indication of a problem. These decisions should not be based upon unit cost alone.

4. Availability of Forecasts for End Products

During the review, it was determined that none of the task statements contained forecasts for end products or their "drivers". One task statement contained written instructions for an activity to review a specified number of Engineering Change Proposals (ECP's) and maintain surveillance of a specified number of technical manuals and Maintenances Requirements Cards (MRC's). [Ref.11:p1-2] These are instructions to screen technical documentation to evaluate its impact upon the training curricula for specific equipment (Periscope), they are not a forecast, per se.

Another task statement specified the percentage of a particular training curriculum that is to be maintained during one fiscal year. The background section of the task statement contains the following statement of work [Ref.12: p1]

> Current curricula maintenance is based on a 20% revision of the entire curriculum, approximately 1,094 pages for 74.8 hours of course instruction. A 20% revision, 219 pages, 15 hours of instruction at a 12 to 1 development ratio is 180 hours or 15K.

This statement appears to be a specification for the performance of a task, not a forecast of the units of output.

Some appropriate questions might be:

* How many Engineering Change Proposals (ECP's) resulted in curriculum changes last fiscal year?

* What was the average unit cost of each curriculum update?

* What is the forecasted number of PECP's that will result in curriculum updates for the coming fiscal years?

* Based upon historical cost data and other considerations, what will each curriculum change cost to produce?

* Could the PECP's be prioritized so that budget cuts could be absorbed by the less critical PECP's?

* Using unit costs and the prioritized PECP's, could the impact of budget cuts be determined?

This type of information is required to analyze each task during the budget formulation process. Although this information is not currently included in the task statements, it is possible to modify the format of the task statements to include it. Generating this information will not be a simple matter. First of all, three decisions will have to be made for each task:

* What unit will we use as a "driver" (requirement), and what will be the unit of output (end product)?

* Does the activity maintain historical data for the selected inputs and outputs?

* Which statistical techniques are appropriate for forecasting these inputs and outputs for the coming fiscal year(s)?

Unfortunately, a research effort might reach a dead-end on one or all of these questions for the following reasons:

* The inputs and outputs may not be easily identifiable and may require considerable debate to be defined.

* Even if field activities have historical data, it may not be well organized and may be difficult to summarize.

* One statistical technique may not be appropriate for forecasting inputs and outputs for every task.

* Field activities may not have the in-house expertise in statistics and operations research to analyze the data.

F. CHAPTER SUMMARY

By now it is apparent that the required data is not currently contained in the task statements. Gathering this data will be time consuming and expensive, and will likely involve the assistance of a consulting team that specializes in statistical analysis. Such a project will require strong support from the Program Manager to ensure the full cooperation of the field activities.

Fortunately, gathering the data and defining the units of input and output will be the hardest part. Once a baseline is established, each field activity could be required to maintain the necessary data, use the established forecasting techniques, and provide the forecasts to the Logistics Division. The Logistics Division could then load the forecasts into a central data base. Using an analytical program, the Logistics Division would then be able to calculate unit costs (both variable and total) and determine budget requirements for the coming fiscal year. This same data base could be used to determine the impact of budget cuts on logistics products and services.

Chapter IV will discuss a model that can be used to predict the funding requirement for a particular task, and determine the impact of budget cuts on end products if funding were reduced.

IV. MEASURING LOGISTICS PRODUCTS AND SERVICES

Chapter III concluded that the primary source document for the Logistics Division budget, the Task Statement, does not contain the type of information required for forecasting unit costs and for predicting the impact of budget cuts on logistics products and services.

This information needs to be gathered. Its collection will be time consuming and will require the input of Logistics Division personnel to identify the "drivers" and end-products. Some of this information will be found at NAVSEA headquarters. The remainder can be obtained by tasking the field activities to provide it.

Unfortunately, this data could not be assembled in time for this thesis. The data that is used is fictitious and is used to demonstrate the models presented in this chapter. The two models that will be demonstrated (multiple regression and unit cost) are already established and are commonly used today.

A regression model will be presented to forecast units of input and output. The unit cost model is similar to the one currently used by the Department of Defense (DOD). This model will be modified to reflect the concept of marginal cost (MC). The DOD model is based on average total cost (ATC). This modified unit cost model can determine the impact of budget

cuts if "drivers" and end-products can be forecasted. The unit cost model divides last year's forecasted end products into the sum of last year's variable costs for those units.

Finally, Chapter IV will discuss a method of allocating budget cuts across the logistics division budget. This method is related to the Zero-Based Budgeting (ZBB) concept where decision units are prioritized and minimum funding limits are set for each sub-task. The possibility for a computer application will also be discussed.

A. ASSUMPTIONS

Before discussing the regression model, there are two main assumptions which must be addressed.

1. Units of input ("drivers") and output (end-products) have been identified.
2. Adequate historical data regarding total costs and units produced is available for analysis.

As previously discussed, analytical methods such as regression rely on the measurability of inputs, outputs and the availability of historical cost and production data. This historical data must be collected and grouped before analysis can begin.

In the case of the Logistics Division, it is also assumed that the Logistics Division staff will be able to identify "drivers" and end-products, similar to those described in Chapter III, and choose the correct unit of measure for each.

Some of the data can be obtained from Logistics Division files. Other data may not be as easily gathered. For instance,

due to space limitations, some government activities only retain documents for several fiscal years. If a regression analysis is to provide optimum results, it is suggested that a sample be drawn from data ranging from the very beginning of the Trident program to the current fiscal year.

Gathering the sample data may require an extensive search of the archives that are maintained by other commands. For example, the Trident Training Facility (TTF) is a good source of information for the number of curriculum updates generated during fiscal year. A number of field activities may need to be queried in order to obtain the data required for multiple independent variables that will be used to derive a regression model for one just task.

It is also assumed that only those inputs (independent variables) with the strongest relationship to the output (dependent variable) will be analyzed. Regression is most applicable where a strong relationship exists between the dependent and independent variables, such as PECP's and curriculum updates. This is where experience is invaluable. Without the benefit of human judgement, a truly accurate model can not be derived.

The discussion that follows is intended to describe regression analysis as a useful tool for predicting levels of output based upon the influence of one or more inputs. The examples used in this chapter are provided only to illustrate that regression can be used to forecast an expected output,

such as curriculum updates. Regression may not be useful in all cases, particularly when there are externalities not considered by the model.

While using analytical techniques is preferred, a sophisticated technique such as regression may not be necessary in all cases. Managers at the Logistics Division and field activities can (and do) make reasonable forecasts based upon intuitive judgement. For instance, the issue or receipt of repair parts is an output that is measured by many supply activities. The issue rate for parts generally increases as equipment ages and hours of operation increase. When forecasting the issue rate, a reasonable estimate can be derived by reviewing the past history of issues, and extrapolating a figure based upon equipment age or total hours of operation.

Another option may be to query other commands who track similar information. For example, the Naval Sea Logistics Center (NAVSEALOGCEN) or the Navy Ships Parts Control Center (SPCC) may already have established a model for forecasting repair part consumption based on equipment age or other variables. If the Logistics Division develops a full scale computer program, using existing models is an economical alternative and should be explored.

B. THE USE OF REGRESSION ANALYSIS

This section will discuss the use of regression analysis to forecast "drivers" and end-products for budget formulation.

Regression is a formal decision model. As discussed in Chapter II, formal models are tools that managers can use to make more accurate business decisions than those made by intuition alone. A formal decision model may recommend a choice that may still be rejected by a manager due to externalities that cannot be incorporated into the model.[21] Decision models do not provide perfect choices. Professor Shu S. Liao stresses that although formal decision models are imperfect, they are still better than decisions made by intuition alone.

> The test of success for any analytical technique is not whether analytical models are the perfect answer to the manager's needs, but whether such models provide better answers than would have been achieved with out them. [Ref.6: p3]

1. What is Regression Analysis?

Regression analysis is a description of the nature of the relationship between two or more variables. [Ref.6: p1] The objective of regression is to describe or estimate the value of one variable (called the dependent variable) based upon its relationship with one or more explanatory (independent) variables.

In the case of the Logistics Division, an appropriate dependent variable would be Curriculum Updates, which are an end-product. The value of this output can be determined based upon its relationship with a number of independent variables, such as PECP's or tactical changes.

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[21] "Externalities" refer to political, behavioral or other factors that will influence a decision. These are factors that could not be quantified and incorporated into the model.

2. The Simple Regression Model

In most cases, the relationship between the dependent variable (Y) and the independent variable (X) is assumed to be linear and is represented by a straight line. A regression model is an algebraic equation for a straight line where the value of the dependent variable (Y) relies upon the value of the independent variable (X). (Simple linear regression models have only one independent variable). This linear equation is shown in Figure 3, where (Y) is the dependent variable or the value of the end-product that we are trying to forecast. (a) and (b) are parameters estimated during the regression analysis. When the regression equation is plotted on a two dimensional graph, (a) is also the (Y) intercept, or the point where the regression line crosses the vertical (Y) axis. (b) is the slope of the straight line. (b) is also the coefficient that will be multiplied by the value of the selected independent variable (X). The product of this multiplication will be added to the constant (a) to obtain the value of (Y) (which is our objective).

$$\boxed{Y = a + bX}$$

Figure 3

Returning to the example, (Y) represents the curriculum updates (output) based upon a number of PECP's

(input) represented by (X). Assume that a regression equation was calculated from data consisting of the yearly totals for curriculum updates and the corresponding totals for PECP's processed in each of the fiscal years chosen.[22] Figure 4 represents the resulting regression equation.

$$Y = 1.5 + .75X$$

Figure 4

The Training Branch Head is interested in obtaining a forecast for the number of curriculum updates expected for the following fiscal year. From a separate analysis, he has determined that the Logistics division expects to process approximately 70 PECP's during that period. (Some PECP's will not result in curriculum updates). By substituting (70) as the (X) value, the regression equation produces an approximate value (54) for the expected number of curriculum updates that

[22] The regression calculation process is complex and will not be discussed. This discussion is intended to provide an overview as to how a regression equation (once it is calculated) can be used to predict the value of the dependent variable (Y).

will be generated if the Logistics Division processes 70 PECP's. Figure 5 illustrates this example.

1) $Y = a + bX$

2) $Y = 1.5 + .75X$

3) $X = 70$

4) $Y = 1.5 + .75(70)$

5) $54 = 1.5 + 52.5$

Figure 5

3. The Multiple Regression Model

Simple linear models are calculated quickly and easily interpreted. Unfortunately, real world problems are seldom so simple that a single explanatory variable will accurately determine the value of the dependent variable. For example, even though there is a strong relationship between curriculum updates and the number of PECP's processed, it is unlikely that the best regression model will be derived using only one independent variable. As previously discussed, tactical changes and Trident Command and Control Problem Reports (TCPR's) are also related to curriculum updates. These variables may also have a significant influence on the curriculum updates.

By collecting additional information, such as the yearly totals of tactical changes and TCPR's, our regression

analysis is expanded by two new variables (X_2) and (X_3). The new multiple regression model appears in Figure 6.

$$Y = a + b_1X_1 \; b_2X_2 \; b_3X_3$$

Figure 6

The independent variables (X_2) and (X_3) represent tactical changes and TCPR's respectively. As additional variables are added, calculating the regression equation becomes an increasingly complex task. Hand calculation is extremely time consuming, and is prone to error due to the myriad of arithmetic operations involved. Rounding errors can also diminish the equation's accuracy.

Nowadays, manually calculating multiple regression models is unecessary. There are many statistical software programs currently available on the open market. These programs can calculate a regression equation involving many independent variables in less than one second. One commercial program in common use at the Naval Postgraduate School is MINITAB.[23] MINITAB not only calculates a regression equation, it provides a wealth of additional information. Figure 7 is a

[23] MINITAB is the registered trademark of MINITAB, Inc. Copyright 1989.

sample MINITAB printout for a simple regression model involving one independent variable (C1) (the X variable). [Ref. 6:p5]

```
MTB > regress C2 1 C1

The regression equation is
C2 = 11.8 + 17.4 C1

Predictor    Coef     Stdev  t-ratio    p
Constant     11.769   3.936     2.99    0.010
C1           17.385   1.215    14.31    0.000

s = 7.263    R-sq = 93.6%    R-sq(adj) = 93.1%

Analysis of Variance:
SOURCE       DF        SS       MS       F        p
Regression    1     10805    10805   204.84    0.000
Error        14       738       53
Total        15     11543

Unusual Observations
Obs.       C1       C2     Fit    SdevFit    Resid.
16       7.00    127.00  133.46    5.33     -6.46 X
X denotes an observation whose X val. gives it
large influence.
```

Figure 7

The MINITAB command "regress C1 1 C2" instructs the computer to perform a regression analysis of the relationship between the dependent variable (C2) and the independent variable (C1). The regression equation "C2 = 11.8 + 17.4 C1" is analyzed in the sections below the equation. For example, the "t-ratio" for the independent variable (C1) is 14.31. This value indicates that the independent variable is a good predictor for the dependent variable (C2).

The value "R-sq = 93.6%" is called the "coefficient of determination" or "R^2". It measures the "goodness of fit" for the regression equation. An R^2 of close to 1.0 indicates that the regression equation closely describes the relationship between the dependent and independent variables. In this case, the R^2 value of 93.6% indicates that 93.6% of the sample variation from the mean of the dependent variable can be explained by a change in the independent variable. In other words, this looks like a good equation.

Other information contained in the sample printout indicates that one of the sample observations (observation 16) exerts a large influence on the regression equation. If this value were plotted in relationship to the other observations, it would appear as an outlier. The observation is also 5.33 standard deviations from the mean, which is another indication that it is an outlier.[24]

In addition to the regression printout, MINITAB will also plot the values of (X) and (Y) on a two dimensional line graph to allow the user to assess the linearity of the relationship. MINITAB can also display a histogram which can be used to judge whether or not the probability distribution for each variable is normal. If either the linearity of the

---

[24] In a normal probability distribution, 90% of the observations will fall with 1.64 standard deviations from the sample mean. An observation that is 5+ standard deviations from the mean in outside of this parameter and is normally an outlier.

relationship or the normality of the distribution of the variable is violated, the data may not be useful in its present form. It may need to be transformed in order to produce a useful regression equation.

4. The Need to Transform Data.

Very often, a regression equation is derived that does not satisfactorily fit the data. As discussed in the last paragraph, a regression equation will only be accurate if several assumptions are met. These assumptions are:

* The relationship between the variables is linear.
* The error terms have a constant variance.[25]
* The error terms are not normally distributed.

MINITAB offers a series of diagnostic tests to determine whether or not these assumptions have been violated and which variable or variables is the culprit. When this assessment has been made, a decision can be made to transform one or several variables to another scale. For example, if a relationship appears to be curved instead of linear, a variable or variables can be transformed into their logarithmic equivalent. When this transformed data is plotted on a graph with a logarithmic scale, the result will usually be a straight line. Other options are reciprocal

---

[25] "Error terms" refers to the vertical distance between the actual (Y) value and the calculated value of (Y) called (Y_c) when the variables are plotted on a two dimensional graph. (Y_c) is derived when the regression equation is calculated.

transformation (1/X) and square root transformation. Both the dependent and independent variables may be transformed if necessary.

Transforming the data will not necessarily provide a perfect relationship. The analyst may need to experiment extensively to determine which transformations and combinations of variables will provide the best regression equation. Even though this process may be tedious, such analysis would be nearly impossible without a computer program. With practice, an analyst can quickly interpret the computer output and make the necessary transformations and changes until the best fitting regression equation is determined.

5. Regression Analysis Summarized.

Although this discussion of regression analysis was a brief overview, it was intended to demonstrate that a regression equation can be calculated in almost any situation where historical data is available and there are measurable units of input and output. Computer programs make the calculation process simple. However, interpreting the output and manipulating the data requires experience.

The following paragraphs will discuss how the forecasted values of (Y) can be used in a modified unit cost model when formulating the Logistics Division budget and for predicting the impact of budget cuts on logistics products and services.

C. UNIT COST MODELS

As an example, assume that the Training Branch Head has determined (from his regression model) that he can expect an output of approximately 54 curricula updates if the Logistics Division processes 70 PECP's. When formulating his budget, he can use this information to estimate next year's allocation for a task performed by the Trident Training facility.

1. A Unit Cost Model for Budget Formulation

The unit cost model that is used by the Department of Defense (DoD) divides last year's total cost by the expected output for next year. The result is an average total cost. While this model is satisfactory for computing the standardized unit costs that are used by an industrial activity, it is not useful for budget formulation.

The DoD model assumes that <u>total</u> cost remains constant, even as output changes. (This year's budget baseline would be last year's total costs, regardless of output). For budget formulation, it would be better to assume that the <u>average total cost</u> remains constant as the expected output changes. The following example will clarify this difference.

From budget records maintained by the Business and Financial Management Division (PMS 396P), last year's total cost for a particular task was determined to be $75,000. This total cost is then divided by the total number of units produced <u>last</u> year (assume 65 units were produced). The result is an average total or unit cost of $1,154.00 per curriculum

update. To obtain a budget baseline for the task, the Branch Head multiplies the 65 expected curriculum updates by $1,154.00. The resulting baseline is $62,316.00. Figure 8 illustrates this example.

Total costs from last FY		$75,000
Divided by:	Total Units produced last FY	65
=Average Total Cost (last FY)		$1,154
Multiplied By:	Expected Number Curriculum updates	54
=Baseline Allocation (next FY)		$62,316

Figure 8

This baseline figure is only a starting point. It can be adjusted upward or downward to reflect other factors that may not have been accounted for in the model. For instance, the Branch Head may desire to compare the unit cost to the unit costs for the same task in previous years, or to the unit cost for a similar task performed by another activity.

In addition to comparing the average total costs, the Branch Head may be aware of externalities that will affect either the expected number of curriculum updates or the amount of funding that will be available to produce them. Also, the Branch Head can use his average total cost as a "sanity check" for the budget request that will be submitted by the activity.

2. A Marginal Cost Model for Budget Cuts

While average total costs are useful for budget formulation, they cannot be used to predict the impact of budget cuts on logistics products and services.

Chapter III discussed the total cost equation (Figure 1) where total cost is comprised of two elements, fixed costs and variable costs. Variable costs fluctuate with the level of activity (in this case, the number of curriculum updates produced). Fixed costs do not change with activity level (refer to Chapter III, paragraph 2 for examples of fixed and variable costs).

Assume that the total cost of $75,000.00 used in the last example is broken down into its fixed and variable elements. The total cost function is a linear equation that resembles the regression equation (Figure 5) where $Y = a + bX$. In the cost equation, fixed costs are represented by the constant (a). The coefficient (b) represents the variable cost element. The independent variable (X) represents the expected volume of curriculum updates.

Using a fictitious linear cost equation as an example, marginal cost is determined by taking the first derivative of total cost with respect to quantity. In this equation, the dependent variable (Y) represents Total Cost (TC), (X) is the

expected output calculated from the regression equation and fixed and variable costs are \$428.00 and \$643.00, respectively. Figure 9 illustrates this example.

(1)	$Y = a + bX$
(2)	$Y = 428 + 643X$
(3)	When $X = 0$, $Y = 50$ (total cost = fixed costs when quantity = 0, therefore...
(4)	$MC = \Delta TC/\Delta Q = \Delta VC/\Delta Q$
(5)	$MC = \Delta VC$
(6)	$MC = 643$ per unit

Figure 9

In this case, marginal cost equals the average variable cost per unit because the cost function is linear and variable cost is a constant. If the cost function were not linear (i.e. curvilinear), marginal cost and variable cost would not be equal.

Marginal cost is an appropriate measure for analyzing the impact of budget cuts on logistics products and services. Figure 10 demonstrates how marginal costs can be used to

determine the impact of a budget cut on a task that has curriculum updates as the end product.

Predicting the Impact of a Proposed Budget Cut Using Marginal Costs

ACTIVITY A:

(a)	Funds Authorized 1 Oct. 1992	$75,000
(b)	Balance, 30 January 1993	$50,000
(c)	Amount of Proposed Cut	$10,000
(d)	Marginal Cost per Unit	$643
(e)	Expected Number of Unfunded Curriculum Updates (c/d)	16

Figure 10

These are simple models. They are not intended to be the only decision criteria used when assessing the impact of budget cuts. These models are highly dependent upon the quality of the forecast for expected units, even if the quality of the historical cost data is excellent.

D. BUDGET CUTS USING A ZERO-BASED MODEL.

Zero-based budgeting is not a new concept. It is associated with the Planning, Programming and Budgeting System (PPBS) implemented by former Defense Secretary Robert S. McNamara and his team of operations analysts during the Kennedy administration in the early 1960's.

Zero-based budgeting involves breaking the budget down into decision units. In the case of the Logistics Division budget, a decision unit could be a WBS task or sub-task. Each decision

unit is then analyzed to determine the lowest level of funding at which the task can still be performed. This level becomes a "floor." If funding is cut below this "floor," the task can no longer be performed.

After minimum funding levels have been set, each task is prioritized by the cognizant manager. The manager is then required to prepare his defense for each task, and present his defense to a decision making body who will assign funding in accordance with the priorities chosen by the cognizant manager.

This approach to budgeting is effective, but not popular. Zero-based budgeting has been criticized as being too time consuming and encourages micro-management. Also, this approach introduces an opportunity for "gaming," where a manager assigns lower priorities to tasks with less political visibility and higher priorities to tasks that can advance his personal agenda. The opportunities for "gaming" can be reduced by establishing a committee to assign priorities according to the mission essentiality of each task.

Despite these shortcomings, the zero-based approach has been used with success by some DoD commands. During the interviews mentioned in Chapter III, some of the Branch Heads mentioned using a zero-based budgeting system in the past, and have assigned priorities to their respective tasks.

It should be noted that this zero-based model is only an approximation. The correct approach to efficient budget

cutting is to distribute the cut to tasks where the marginal benefit (MB) per dollar is equalized across all tasks.[26] This "constrained optimization" approach is also useful for budget formulation by allocating limited funds to those tasks where the marginal benefit is greatest, until the marginal benefit per dollar is equalized across all tasks. [Ref. 8:p19]

For example, if a budget cut is to be distributed among 3 tasks, (t1), (t2) and (t3), the optimal condition is where $MB_{t1} = MB_{t2} = MB_{t3}$. This condition can be derived using calculus to maximize the total benefit across the three tasks subject to the constraint of the budget cut.

Although this approach is more accurate than the zero-based model, it is more complicated and time consuming considering the large number of tasks and variables contained in the Logistics Division budget. Although it is a simplified approach, the zero-based model is recommended as a practical tool for budget formulation and execution.

1. Automating the Zero-based Model

A computer program could be written that will use the assigned priorities and funding "floors" to produce management reports that reflect the distribution of a budget cut. For example, the Director of the Logistics Division could assign

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[26] "Marginal Benefit (MB)" is the change in total benefit (TB) that results from the addition of one more unit of input. Marginal benefit is calculated by taking the first derivative of the total benefit with respect to input. (Total cost and total benefit for each task will need to be determined).

priorities to each of his major functional areas in branches L1, L2 and L3, by considering the mission essentiality of each area. According to its priority, each area would be assigned a "weight". This "weight" is nothing more than the percentage of a prospective cut that would be absorbed by each area. The weighting can be adjusted from time to time to reflect changing circumstances.

Within each Branch, each task is assigned a "weight" (priority) and a funding floor by the Branch Head. The program could be written to apportion the dollar value of a cut to each branch in accordance with the "weight" assigned by the Division Director. When a dollar value is assigned to each branch, the "weighting" of each task would determine which task would be the first to absorb the cut. When the lowest priority task is cut to the limit designated during the zero-based budgeting process, the cut will be directed to the next lowest priority task, and so on until the balance of the cut is absorbed. (The branch head can weight his tasks using whatever criteria he considers appropriate).

This zero-based program could also integrate the average total and marginal cost models discussed earlier. The program could determine the dollar reduction absorbed by each task, and divide that value by the marginal cost for a particular end product. The resulting estimated losses of

productivity could be summarized in a management report reflecting a number of different budget cut options selected by the Division Director.[27]

E. CHAPTER SUMMARY

Although the models presented in this chapter are simple, and do not account for all of the factors that influence the volume or costs of logistics products and services, they are a starting point. Under expert supervision, regression models can be refined to provide the most accurate relationship between "drivers" and end products. Diligent collection and organization of cost data will provide a central database which will only require periodic updates to remain current. Field activities can be tasked to provide this information.

Chapter V summarizes this thesis, and provides conclusions and recommendations for further research that can be directed toward implementing a division-wide computer program employing the models discussed herein.

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[27] This scenario is somewhat oversimplified. It is recognized that each task may involve several different end-products which may need to be individually "weighted". Any management report produced by such a system will still be subject to the judgement of the Logistics Division Managers. Despite the shortcomings of this system, it is much faster and more accurate than the methods currently in use.

V. CONCLUSIONS AND RECOMMENDATIONS

This chapter summarizes the main points of the thesis and the conclusions derived from those main points. The chapter will conclude with recommendations for further research directed toward implementing the models presented in Chapter IV.

A. CONCLUSIONS

This study is a preliminary investigation to determine the feasibility of using unit costs to predict the impact of budget cuts on logistics products and services. Although additional research is desirable, the study accomplished this endeavor.

The conclusions are presented in accordance with the main points of the thesis. These point are:

* Improved control methods are needed by the Logistics Division.

* The source document for the Logistics Division budget, the task statement, does not contain the data required to perform quantitative analysis.

* Regression analysis predicts the output of an end product based upon its relationship with an independent variable that "drives" the requirement for that product.

* A unit cost model employing marginal costs can be used to determine the impact of budget cuts on logistics products and services.

1. Improved Control Methods are Needed

Although interviews with Branch Heads (Chapter II) revealed that some control methods are already in use, these methods do not use quantitative techniques such as regression analysis. This is not to say that managers' intuition and judgement of the managers is unimportant. In fact, quite the opposite is true. As discussed in Chapter IV, decisions that are derived from sophisticated analysis still require the experience and judgement of a manager prior to acceptance.

An advantage to adopting quantitative control methods is standardization. At the present time, the methods used to formulate the budget and assess the impact of budget cuts vary from branch to branch. If standard methods were adopted on a division-wide basis, the quality and consistency of management information will improve.

2. Task Statements Do Not Contain the Required Data

The task statements analyzed in Chapter III resemble legal documents and contain relatively little financial information other than the activity's budget request. Task statements can be revised, however. The type of information that is required for quantitative analysis was discussed in chapters III and IV. At a minimum, the statements should contain a detailed cost breakdown of the total budget request to include:

* Total variable costs, such as Direct Material, Direct Labor, and other related direct costs.

* Total fixed costs allocated to that task, broken down into individual expenses such as management salaries, Base Operations Support (BOS) etc.

* Projected travel requirements. These should be organized by trip, destination, number of travelers, and a cost estimate for each trip. (Travel should be considered a direct variable cost when it directly involves production of an end product).

In addition to cost information, the task statements should also identify the end products, their "drivers", and forecast the volume of these products for the budget year. The definition of these end products,"drivers", and the appropriate forecasting technique should be a joint decision made by the Logistics Division and the activity.

3. Regression Analysis Can Be Used to Predict Output

Chapter IV discussed using regression analysis to predict the volume or output of an end product based upon its relationship with the "drivers." Although an actual regression analysis was not performed, the close relationship between some of the identified products and drivers and end products identified indicates that regression is a viable option for the Logistics Division.

Regression may not be necessary or applicable in every case. Some of the forecasting techniques currently in use may provide an adequate projection of future requirements. Projecting the output for each task is the key to using the model presented in Chapter IV.

4. A Unit Cost Model Can Be Used for Budget Cuts

The unit cost model presented in chapter IV is a simple tool that is intended to enable decision makers to assess the impact of budget cuts. Even though this model will not provide perfect results, it will provide information that is more reliable and accurate than would have been otherwise obtained without a formal model. The intuition and judgement of the Logistics Division managers is still required to validate the results derived from this model.

Due to the complexity of the budget, this model will have to be used as part of a computer program. The program should allow the Logistics Division managers to select a method of applying a budget cut and calculate the impact on logistics products and services. These calculations will estimate the impact of a particular cut and allow managers to make informed decisions. A computer program will also shorten the time required to report the impact of budget cuts up the chain of command.

B. RECOMMENDATIONS

It is recommended that the Logistics Division initiate research that is directed toward defining the end products and "drivers" for each WBS line item. At first, this project should be confined to a segment of the O&MN budget such as the Training Branch. Once the "drivers" and end products have been defined for each task/sub-task, the following steps should be taken:

* Gather historical data for each "driver" and end product. Data should extend over the life of the program and include both cost and production figures.

* Perform regression analysis using the historical data. It is recommended that this analysis be conducted by someone with considerable experience in regression and statistics.

* Using the marginal cost model presented in Chapter IV and the forecasts that result from the regression equations, construct models for as many tasks as possible.

* The models need to be tested. The type of tests to be performed cannot be determined until the regression analysis is completed. The ultimate success of the regression models is subject to the judgement of the managers with cognizance over the task being evaluated.

* If the Logistics Division managers are satisfied with the models, the services of a software development firm should be obtained to develop a proposal for a computer program that integrates the regression models with average variable cost models. This program can be used to assess the impact of budget cuts on logistics products and services.

Prior to initiating these steps, the Logistics Division Director needs to analyze the costs and the potential benefits that will be derived from additional research and development of a computer program. Needless to say, gathering the required data, performing the analyses, and hiring a software firm will not be inexpensive.

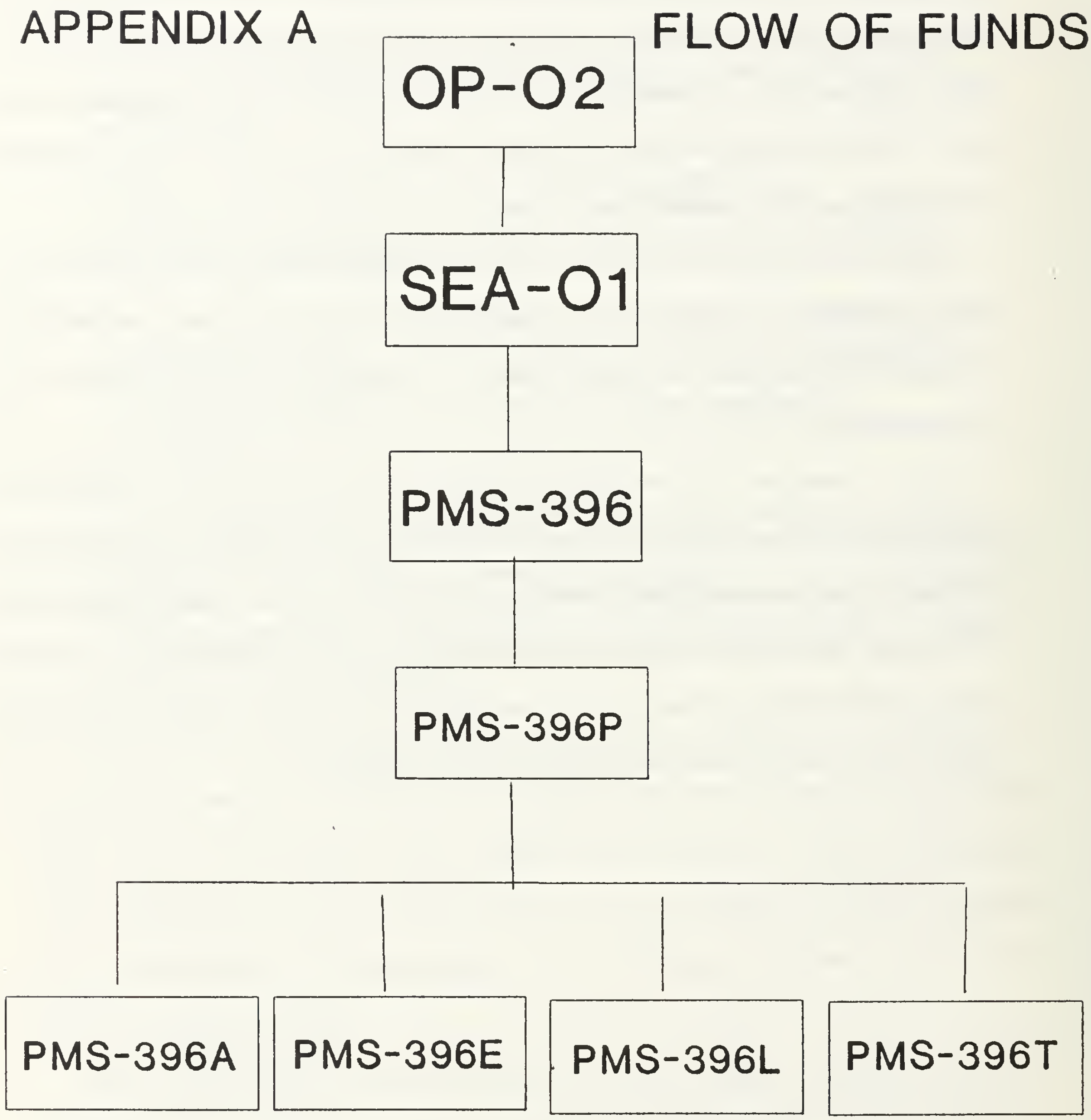
When assessing the costs and benefits, the managers should consider the cost of the project in relation to the size of the Trident Logistics budget. Also, a computer program is an investment rather than an expense. With a large program budget, such as Trident, the effect of efficient management decisions over a long period of time will outweigh the

original software development costs. The last consideration is that the benefits of a successful computer program will not be confined to the Trident program. The Trident budget format is not unique. If a computer program is developed, commonality with other government program budgets will make the project even more cost effective.

These recommendations are only suggestions. Recommendations will probably change as additional research is performed. Similarly, the models mentioned in Chapter IV may not work in all cases.

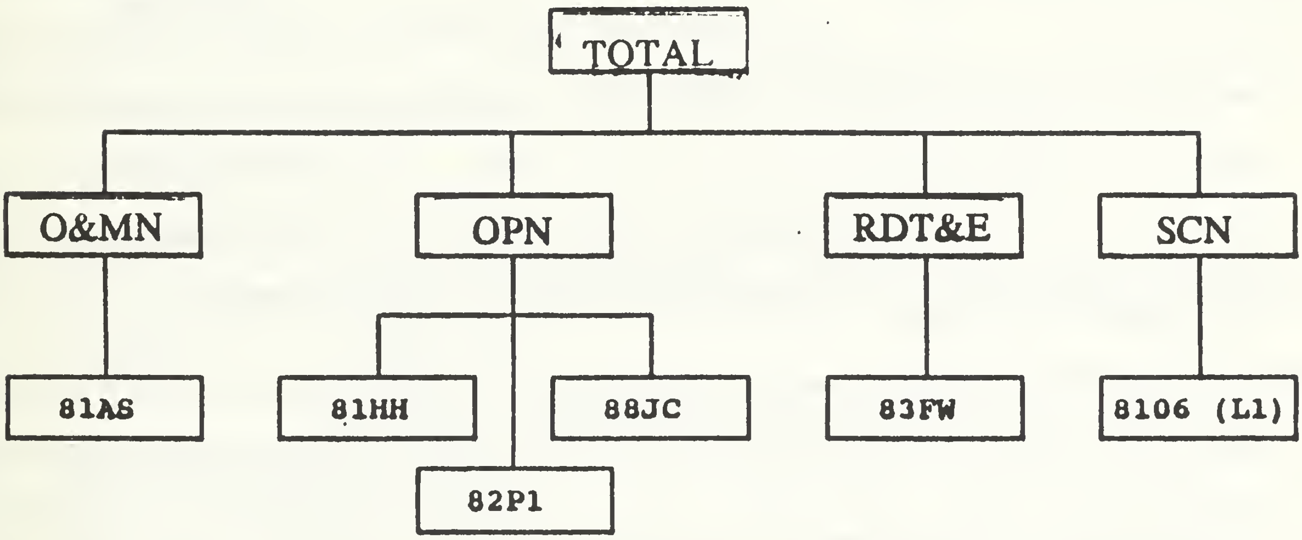
This thesis is a preliminary investigation. Follow-on researchers can use the background information and theory behind the recommended models to perform the actual on-site analyses and make firm recommendations. This thesis can serve as a foundation block for a series of studies that will build upon and refine the ideas contained herein.

APPENDIX A


APPENDIX A
FLOW OF FUNDS
OP-02
SEA-01
PMS-396
PMS-396P
PMS-396A
PMS-396E
PMS-396L
PMS-396T

APPENDIX B

Trident Logistics Budget
(PMS 396L)



APPENDIX C

STRATEGIC SUBMARINE TASK STATEMENT

DATE OF PREPARATION 16 July 1991

1. TASK TITLE (WBS TITLE)

PLANNED MAINTENANCE SYSTEM

2. PRIORITY

(A) ______

(B) ______

3. CATEGORY

DESIGN [ ]
INSTALLATION [ ]
DEVELOPMENT [ ]
OTHER [X]

4. MOD

BASIC

5. WORK BREAKDOWN STRUCTURE

1	2	3	4	5	6	7	8	TASK NUMBER

6. PERFORMING ACTIVITY

ACTIVITY (name) ______
LEAD CODE ______
POC ______
PHONE ______

7. PRIMARY EFFORT

CONTRACTOR ______
IN-HOUSE 100%
OTHER GOVT. ACTIVITIES ______

8. PARTICIPATING MGR (PARM)/DIVISION HEAD

NAME Mr. Harry Hall

PHONE ______ CODE PMS 396L

9. PROJECT ENGINEER/COORDINATOR/P.O.C.

NAME Mr. Carl Haines

PHONE ______ CODE ~~PMS 396L3~~

10. TOTAL ESTIMATED COSTS: (NAVY ACTIVITIES ONLY (EXPRESSED IN K DOLLARS)

BY FISCAL YEAR: ALL FISCAL YEARS:$ XXX

91	92	93	94	95	96	97	98
	XX						

11. CONTRACT STATUS

EXISTING ______ NEW ______

CONTRACT NO. ______

CLIN ______

12. DESCRIPTION OF PLANNED EFFORT FOR ALL FISCAL YEARS

A. OBJECTIVE: THE PRIMARY OBJECTIVE OF PMS IS TO MANAGE SHIPBOARD MAINTENAN IN A MANNER WHICH WILL ENSURE MAXIMUM EQUIPMENT AND OPERATIONAL READINESS.

B. BACKGROUND: THE PLANNED MAINTENANCE SYSTEM (PMS) IS DESIGNED TO PROVIDE A SIMPLE AND STANDARD MEANS FOR PLANNING, SCHEDULING, CONTROLLING, AND PERFORMING PLANNED MAINTENANCE ON ALL SHIPBOARD EQUIPMENT AND SYSTEMS.

C. WORK STATEMENT: PERFORM REVIEW DOCUMENTATION FOR ELECTRONIC/WEAPONS HULL/MACHINERY AND ELECTRICAL SYSTEMS.

13. COTR (SIGNATURE)	DATE	14. DIV DIR (SIGNATURE)	DATE	15. PMS396 (SIGNATURE)	DATE
		H.A. HALL		H.K. HOWIE	

SHEET __ OF __ SHEETS

DISTRIBUTION STATEMENT D: DISTRIBUTION AUTHORIZED TO DOD AND DOD CONTRACTORS ONLY: CRITICAL TECHNOLOGY ( ) OTHER REQUESTS SHALL BE REFERRED TO COMNAVSEASYSCOM

- NO. ____________________

PERFORMANCE ACTIVITY NO. ____________________

12. DESCRIPTION OF PLANNED EFFORT 1 OR ALL FISCAL YEARS (CONTINUED)

C. WORK STATEMENT: (CONTINUED)

AND EQUIPMENTS IN ACCORDANCE WITH MIL-P-24534 (NAVY) TO INCLUDE SAFETY, PRECAUTIONS, AND FORMAT.

REVIEW IN-SERVICE ENGINEERING ACTIVITY (ISEA) CHANGED AREA OF MIPS AND MRCS FOR CLARITY AND COMPLETENESS. REVIEW AND CORRECT PMS DOCUMENTATION PRIOR TO DATABASE ENTRY IN THE FOLLOWING AREAS:

(1) INCORRECT OR INVALID STANDARD PMS ITEM NAME (SPIN).

(2) AVAILABLE SPINS NOT ASSIGNED TO ITEMS LISTED IN TEMPT BLOCK.

(3) BIRTH DATE MISMATCHES.

(4) RELATED MAINTENANCE NOT PROPERLY REFLECTED ON MIPS/MRCS.

(5) VERIFY TO SEE IF ALL FACSIMILES FOR A GIVEN SEMI-ANNUAL FORCE REVISION (SFR) ARE INCORPORATED IN PACKAGE.

(6) RED LINING OF MIPS/MRCS NOT IN ACCORDANCE WITH MIL SPEC FOR COMPUTER COMPOSITION.

(7) ENSURE THAT MIPS/MRCS ARE NOT BEING REVISED PURELY FOR COSMETIC REASONS WHICH RESULTS IN UNNECESSARY COSTS.

(8) NEW MIPS/MRCS GENERATED ARE EDITED AND INCORPORATED BY COMMODITY SPECIALIST.

(9) VERIFY ART WORK FOR MINOR CHANGES TO DO IN-HOUSE; OR MAJOR ONES THAT REQUIRE ENHANCEMENT.

FEEDBACK PROCESSING: RECEIVE, PROCESS, RESOLVE IN-HOUSE OR WITH ISEA, AND MAINTAIN AUTOMATED ACCOUNTABILITY OF PMS FEEDBACK REPORTS IN ACCORDANCE WITH NAVSEAINST 4790.33.

DISTRIBUTE AND CONTROL PMS DOCUMENTATION: ACCOMPLISH PRINTING OF NEW AND REVISED PMS DOCUMENTATION. ASSEMBLE AND DISTRIBUTE NEW AND REVISED DOCUMENTATION VIA SPECIAL ISSUE, SEMI-ANNUAL FORCE REVISION AND SEMI-ANNUAL SHORE REVISION (SSR). PROVIDE AND MAINTAIN AUTOMATED PMS LIST OF EFFECTIVE PAGES (LEOP) AS SFR/SSR COMPONENT TO COMPRISE A CURRENT INDEX OF DOCUMENTATION APPLICABLE TO EACH ACTIVITY BY DEPARTMENT AND WORK CENTER.

D. NOTE:

All Trainer Design and Configuration Management Work will be performed by the PARM and/or delivered/reported to PMS396L. O&MN and OPN funding for these efforts are provided via PMS396E funding documents.

SHEET _2_ OF _3_ SHEETS

A: TSNSSC2

... NO. ____________________

...RFORMANCE ACTIVITY NO. ____________________

16. MAJOR SUB-TASKS AND ACTIVITY DESCRIPTION (LIST IN CHRONOLOGICAL ORDER)	17. ACTIVITY PLANNED START = O PLANNED STOP = ▲ ACTUAL START = O ACTUAL STOP = ▼																							
	FY91												FY92											
	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
1. FEEDBACK PROCESSING	O											▲	O											▲
PLANNED MAINTENANCE SYSTEM DEVELOPMENT	O											▲	O											▲
PLANNED MAINTENANCE SYSTEM REVISION	O											▲	O											▲
ESTABLISH AND MAINTAIN COMPUTERIZED	O											▲	O											▲
STORAGE OF MIP/MRC DOCUMENTATION																								
PRINT NEW AND REVISED PMS DOCUMENTATION	O											▲	O											▲
ASSEMBLE AND DISTRIBUTE NEW AND REVISED	O											▲	O											▲
PMS DOCUMENTATION	19. END PRODUCTS SCHEDULE PRELIM = O FINAL = ▲																							
FEEDBACK RESPONSE (RESOLUTION)	O											▲	O											▲
MAINTENANCE INDEX PAGE (MIP)/	O											▲	O											▲
MAINTENANCE REQUIREMENT CARD (MRC)	O											▲	O											▲
COMPUTERIZED DATA BASE	O											▲	O											▲
HARD COPY MIP/MRC	O											▲	O											▲
DISTRIBUTE MIP/MRC VIA SEMI ANNUAL	O											▲	O											▲
FORCE REVISION (SFR) OR SPECIAL ISSUE																								
(SI)																								
. FUNDING PROFILE (K DOLLARS)$ 97																								

SHEET _3_ OF _3_ SHEETS

LIST OF REFERENCES

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